Investigating the Strong Nuclear Force with the OSG

Connor Natzke

Mar. 14, 2022

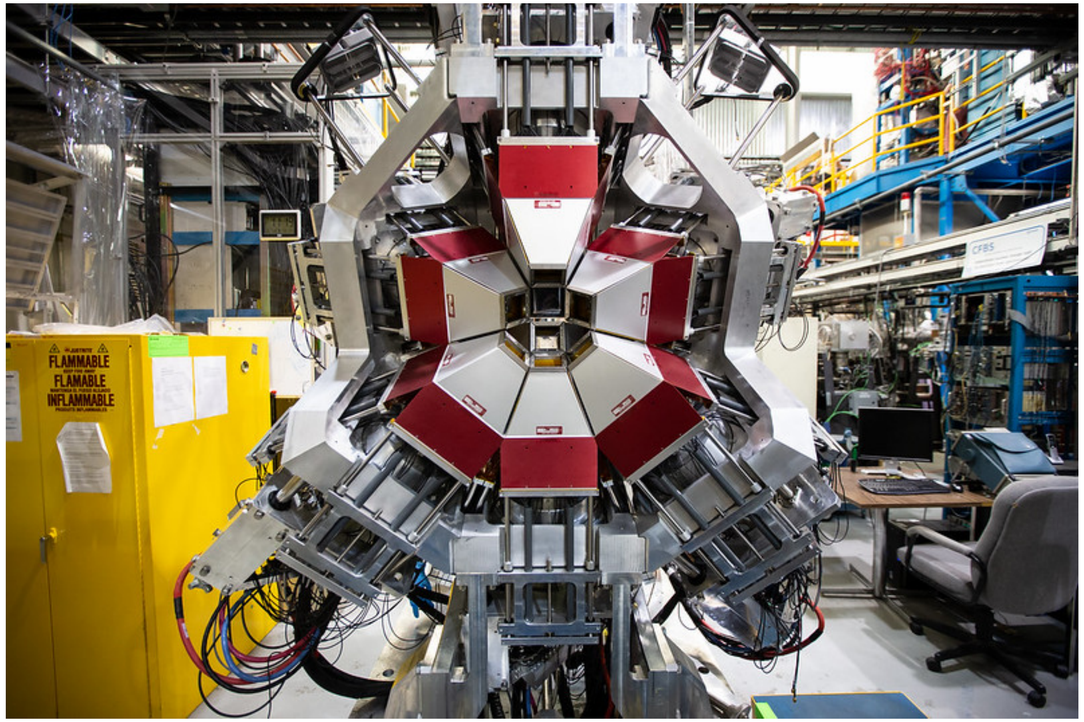
There are four fundamental forces in nature

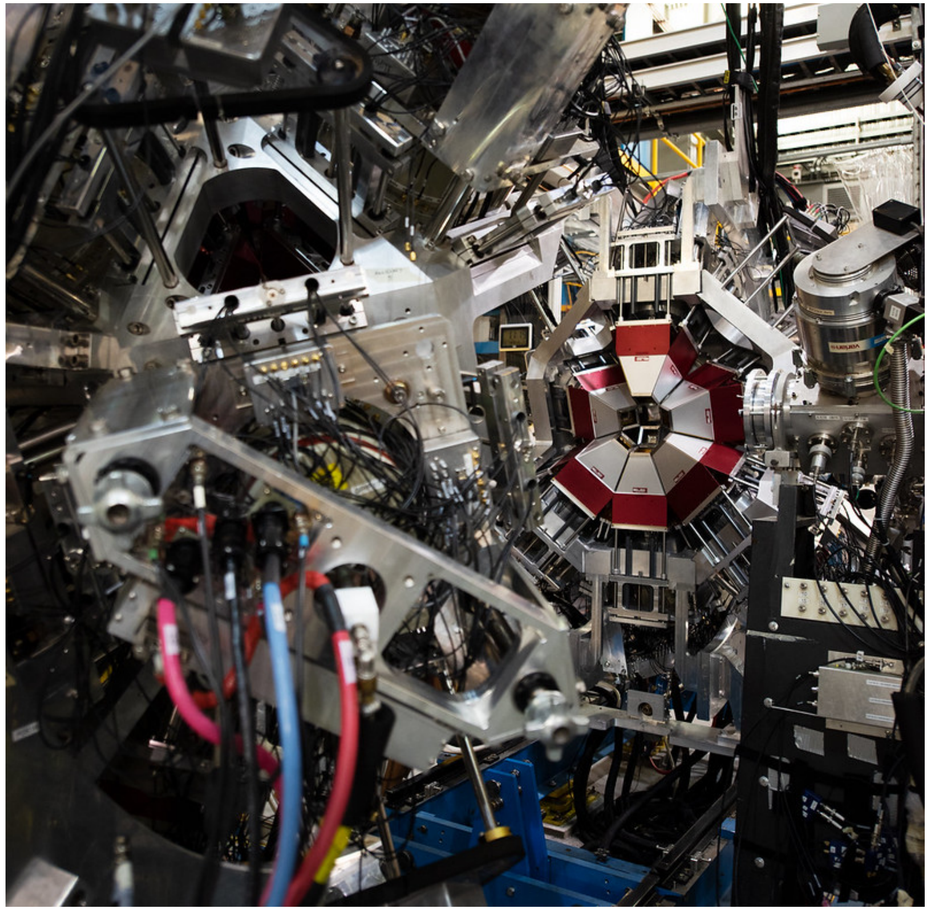
Gravity	Binds the Solar System together
Electromagnetic	Binds atoms together
Strong	Binds the atomic nucleus together
Weak	Radioactive decay

There are four fundamental forces in nature

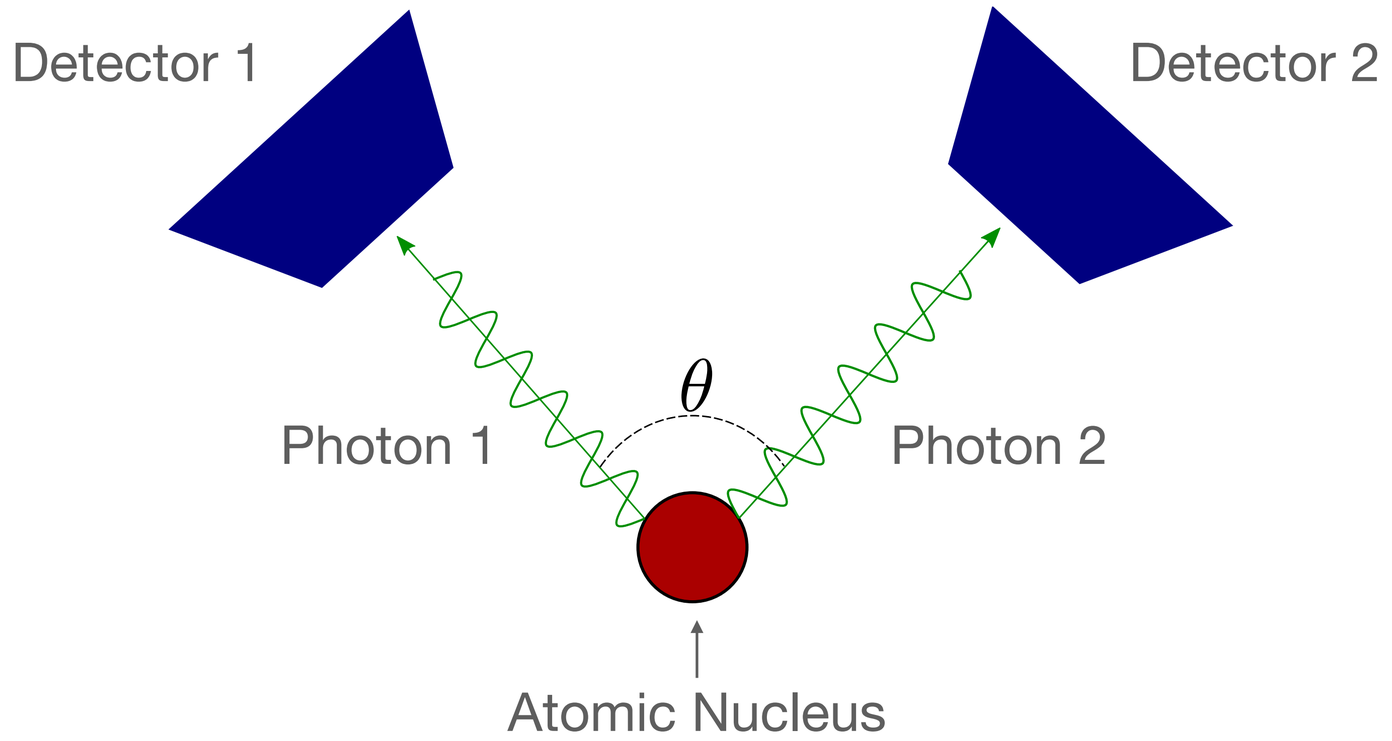
Gravity	Binds the Solar System together
Electromagnetic	Binds atoms together
Strong	**Binds the atomic nucleus together**
Weak	Radioactive decay

The smaller something is the larger the microscope needs to be

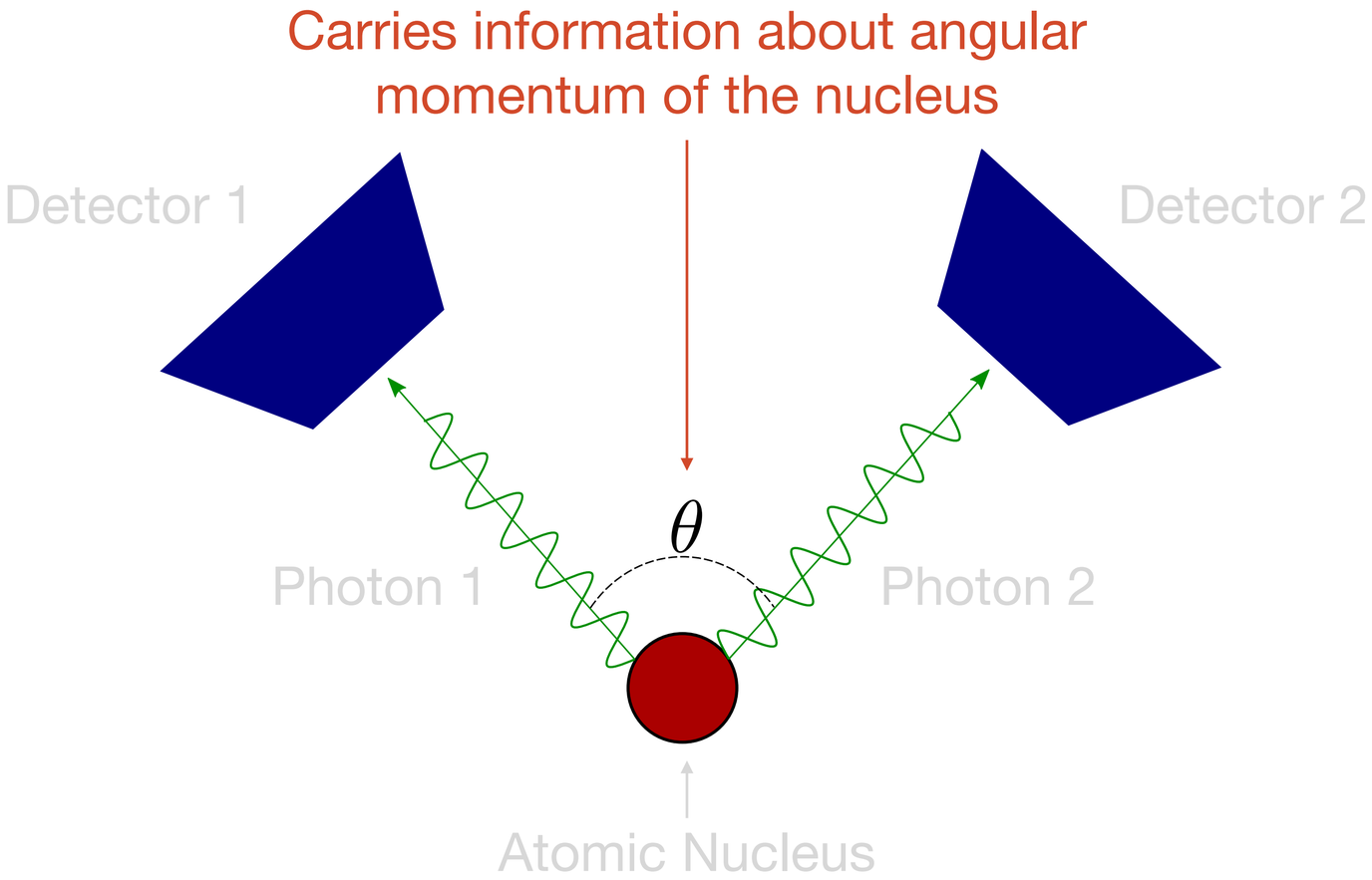




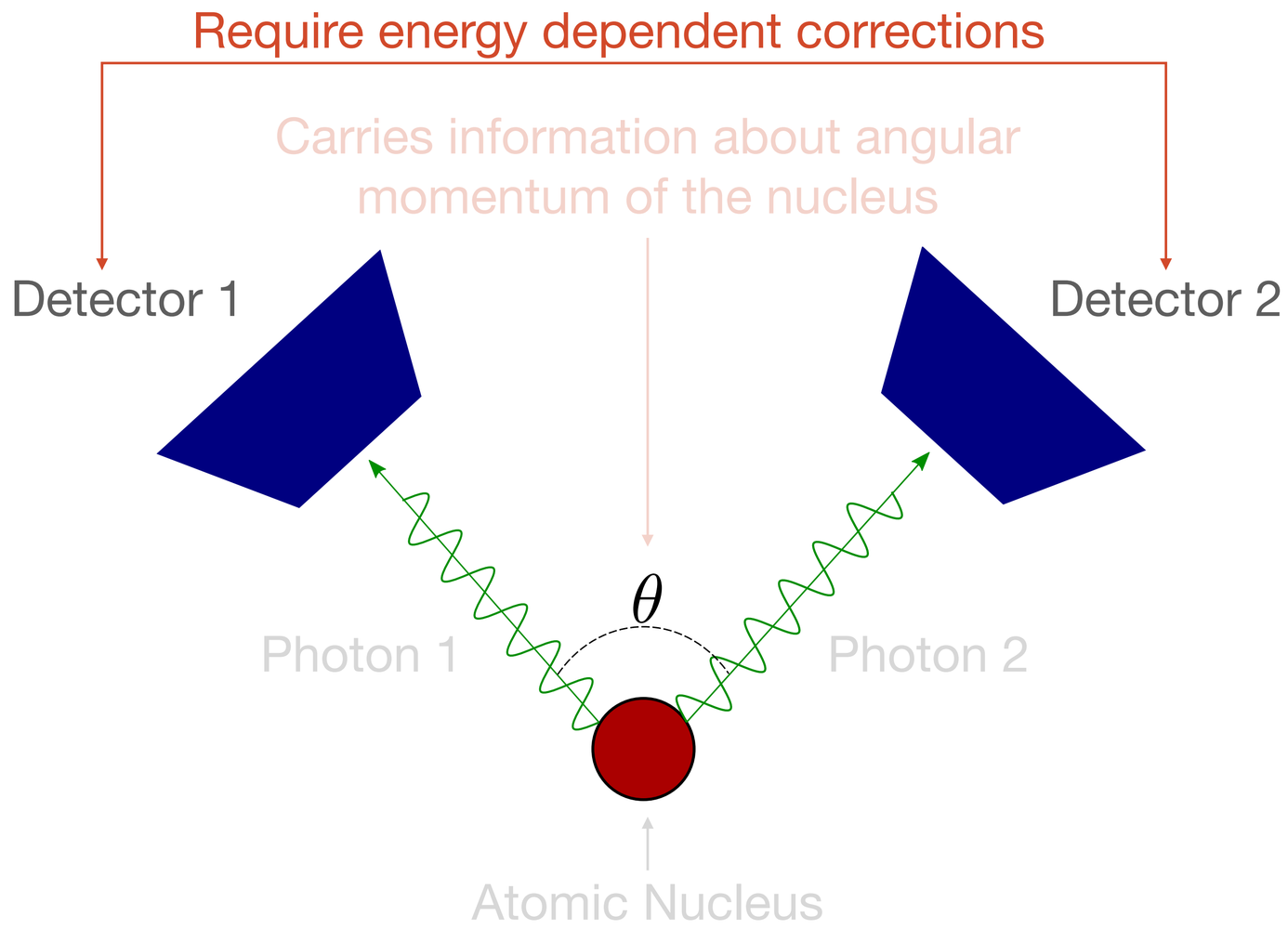
Radiation emitted from atomic nuclei carries information about the structure



Radiation emitted from atomic nuclei carries information about the structure



Radiation emitted from atomic nuclei carries information about the structure

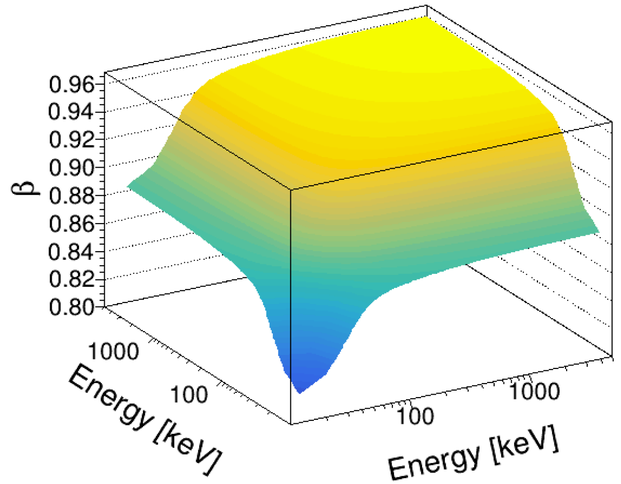


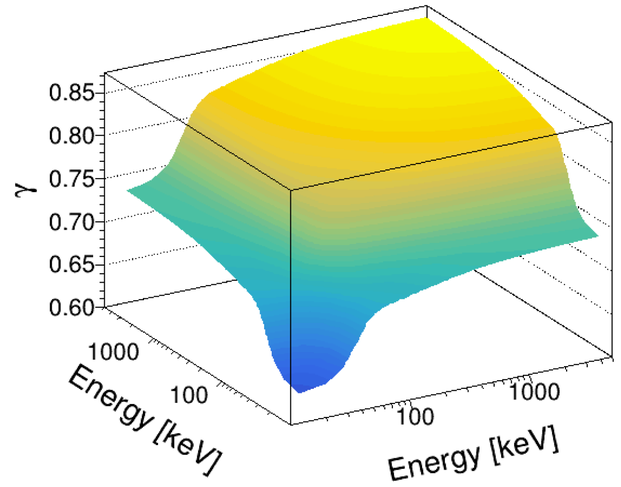
Detectors require correction factors found by mapping an energy surface

Map surface via Monte Carlo simulation

41 points required to map surface

- 3 simulations per point
- 1e9 events per simulation
- ~400 CPU per simulation





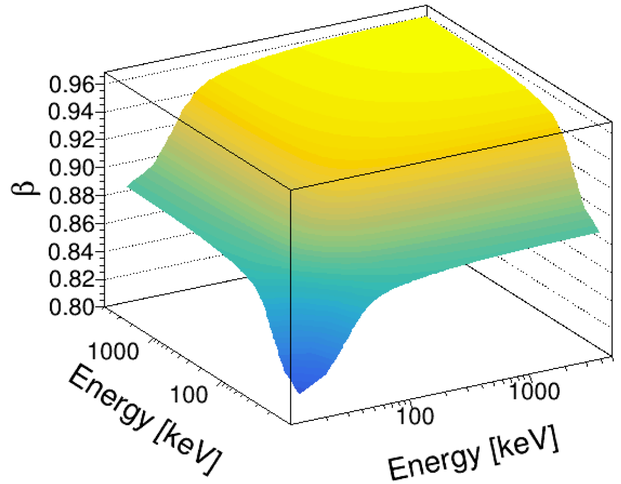
Detectors require correction factors found by mapping an energy surface

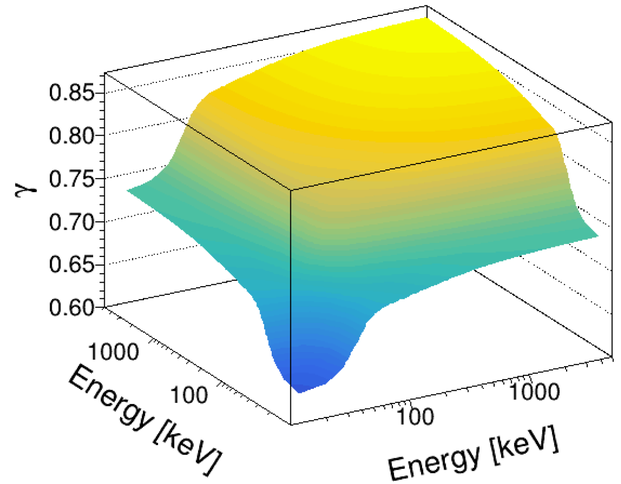
Map surface via Monte Carlo simulation

41 points requested

- 3 simulations per point
- 1e9 events per simulation
- ~400 CPU per simulation

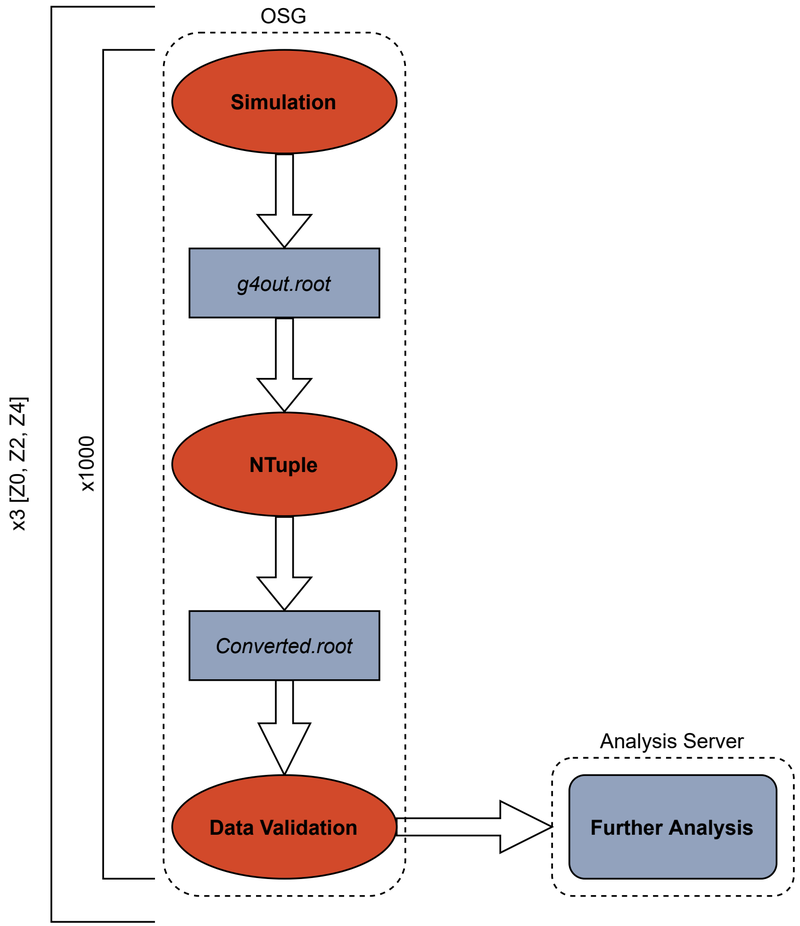
~50,000 CPU hours = 5.7 years!



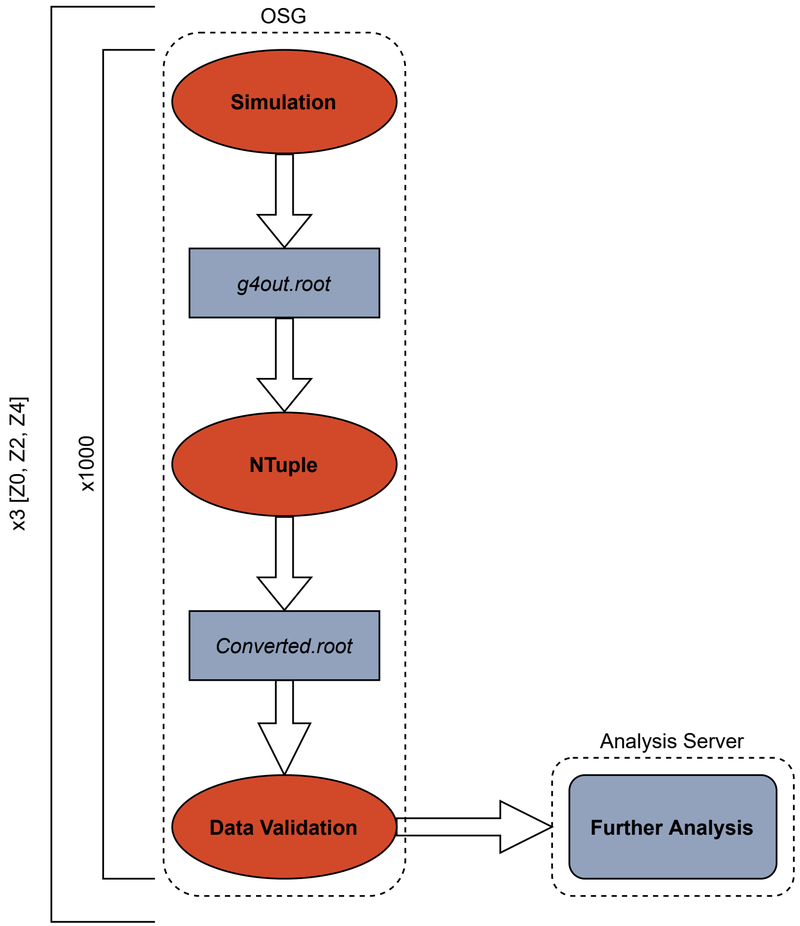


OSG User School 2019

One simulation of 1e9 events broken up into 1000 simulations of 1e6 events



One simulation of 1e9 events broken up into 1000 simulations of 1e6 events

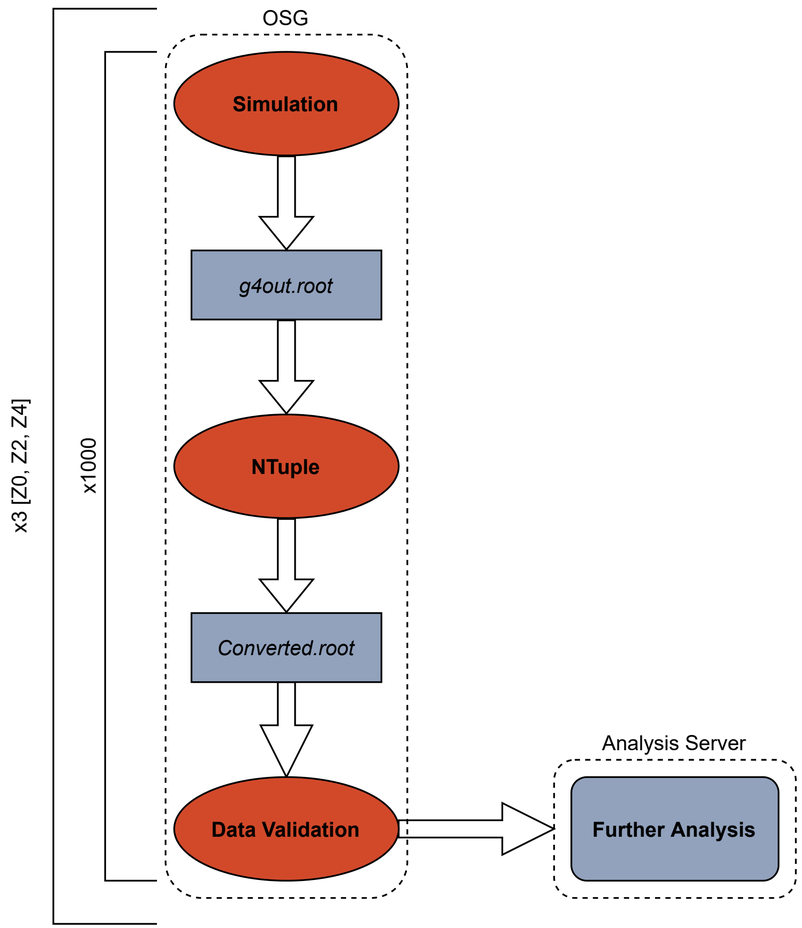


DAGMan handled workflow

Python script created DAG file

Total workflow took ~24 hours

DAGMan was good, but not perfect



Jobs would fail randomly

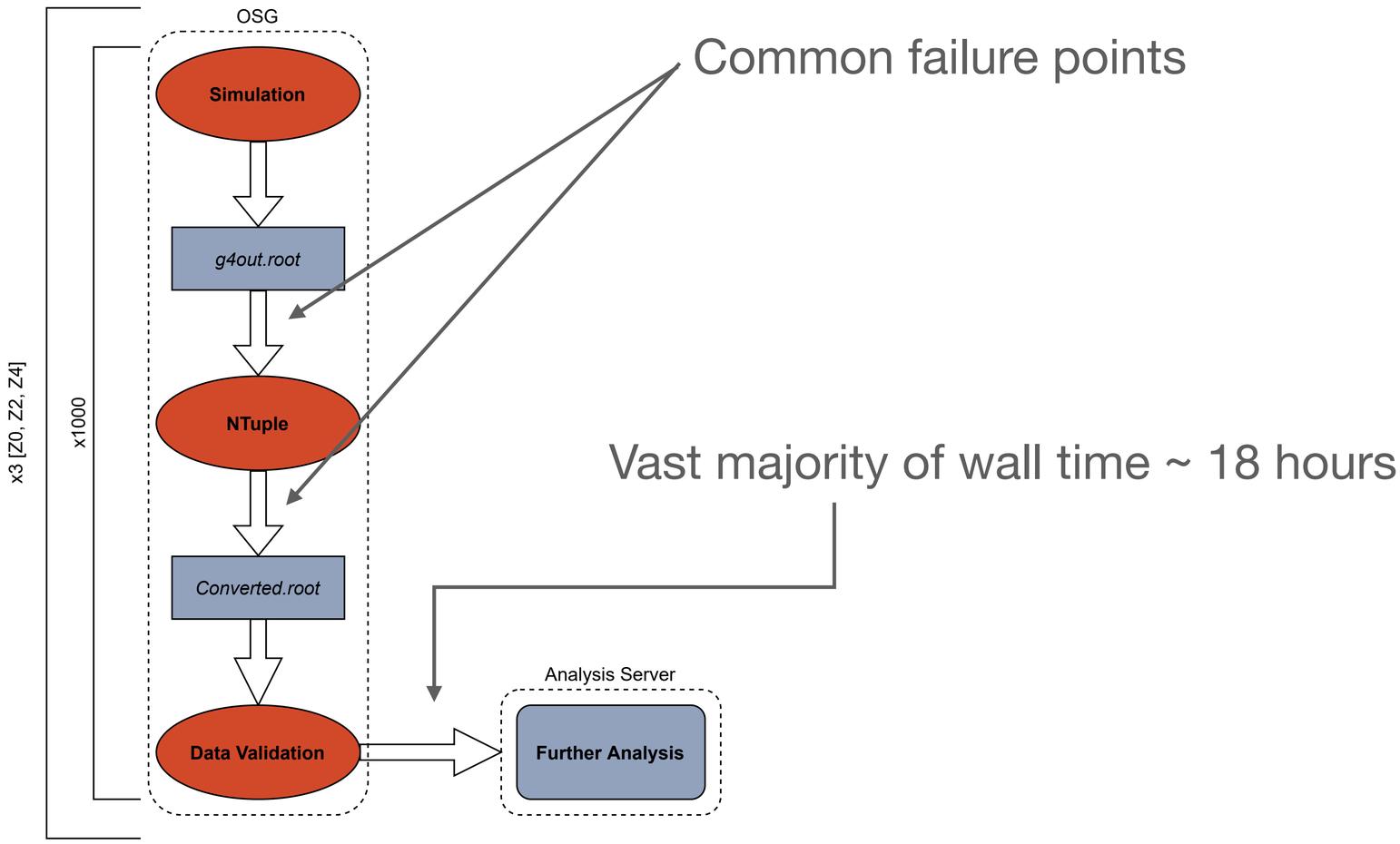
File transfers, bad simulations, etc

Automation reliant on my ability as a programmer

Large memory footprint on submit node

> 400 GB

DAGMan was good, but not perfect



Converted workflow to Pegasus for file management, transfers, and error handling

Jobs would fail randomly

Retried automatically!

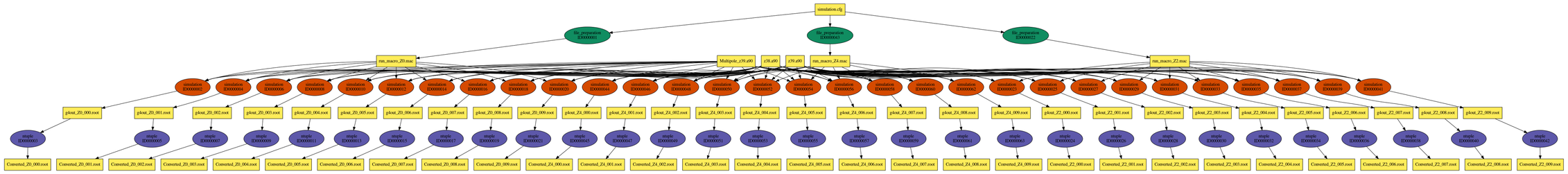
Automation built in

File transfers, clean up, simpler inputs, etc

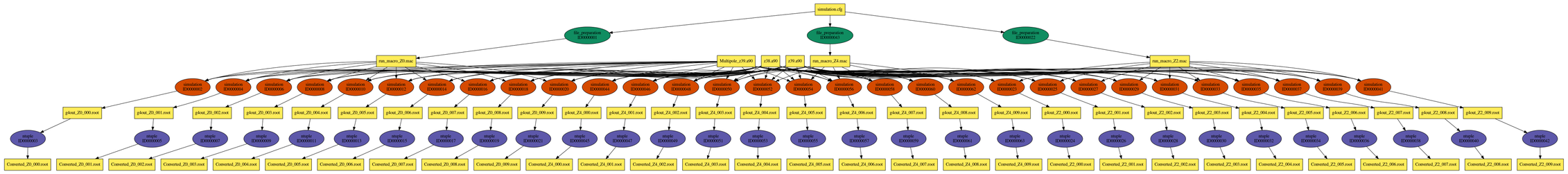
Smaller memory footprint on submit node

< 200 GB

Pegasus allowed for a faster and more robust workflow



Pegasus allowed for a faster and more robust workflow



Total workflow takes ~4 hours!

Using the workflow only takes 3 command line calls

vim simulation.ini

```
[simulation]
z=13
a=34
g1=1193
g2=2588
r=145
```

./make_input_files.sh

./ggac_surface.py

Using the workflow only takes 3 command line calls

vim simulation.ini


```
[simulation]
z=13
a=34
g1=1193
g2=2588
r=145
```

./make_input_files.sh

./ggac_surface.py

Using the workflow only takes 3 command line calls

vim simulation.ini


```
1  [simulation]
2  z=13
3  a=34
4  g1=1193
5  g2=2588
6  r=145
```

./make_input_files.sh

./ggac_surface.py

The OSG has provided a more than 40x increase in simulation speed

	Standard Computation	OSG Workflow
Surface points	*19*	*61*
Wall time	*168 hrs / pt*	*4 hrs / pt*
File management	*Manual*	*Automatic*

Access to the OSG has changed how I approach expensive computational problems

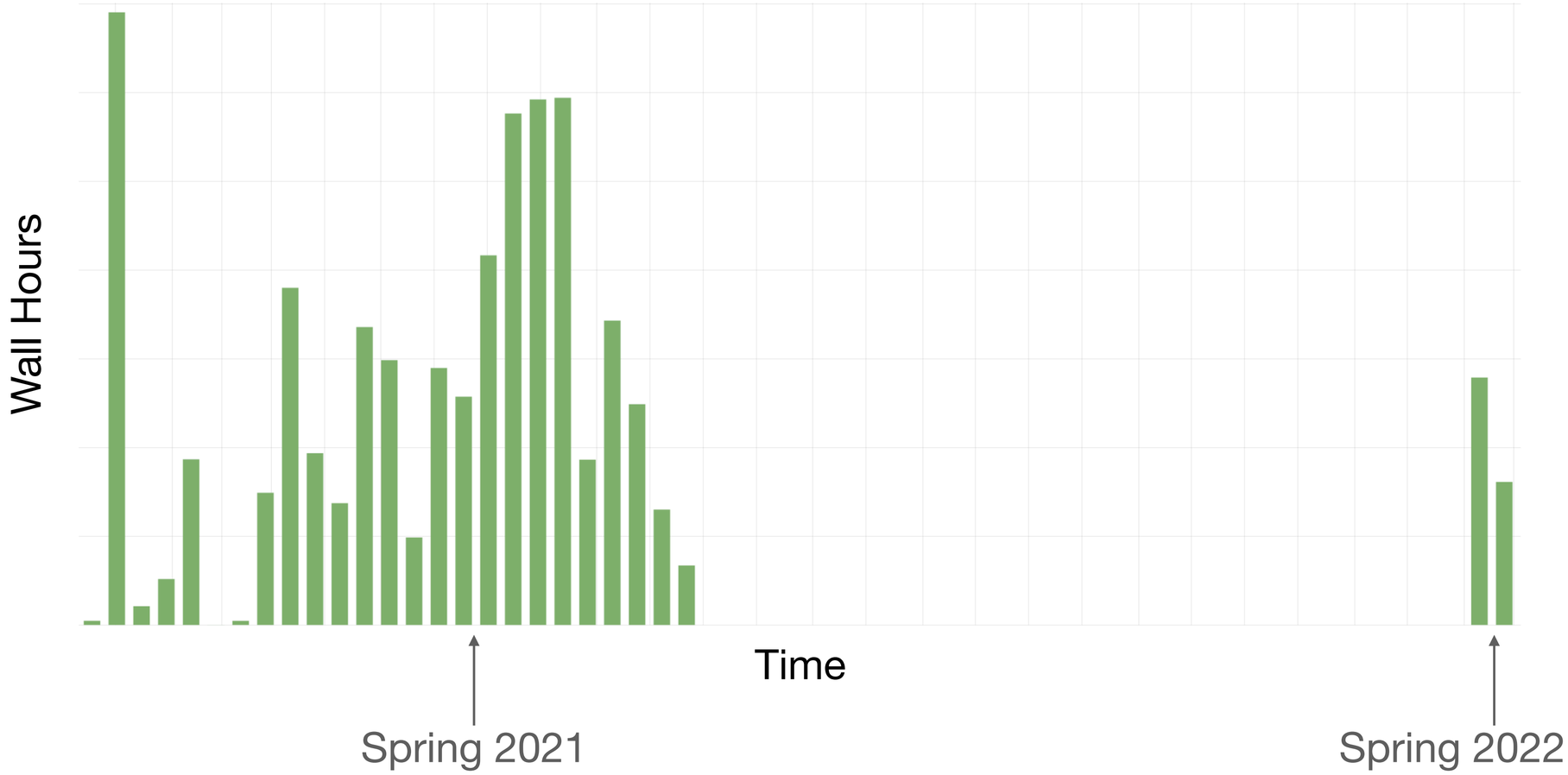
Total Wall Hours:

135k hours

~15 years!

Total Jobs:

590,000



Thank you to everyone who helped me develop my workflow!

Lauren Michael

Mats Rynge

Connor Natzke
cnatzke@mines.edu